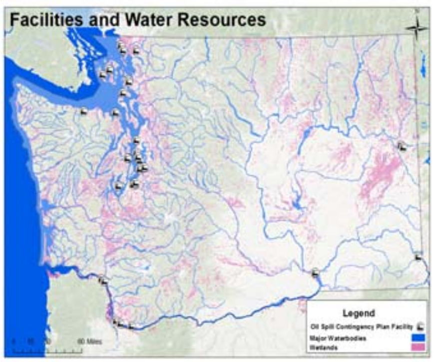
Source: Dr. Bruce Hollebone, Environment Canada, workshop presentation

Source: Bill Jahelka, Western Canada Marine Response Corporation, workshop presentation



Source: Linda Pilkey-Jarvis, WA Dept of Ecology, workshop presentation

Source: Randy Mikula, Kalium Research, workshop presentation

Alberta Oil Sands Workshop

for

Washington State Department of Ecology, the Regional Response Team 10 and the Pacific States/British Columbia Oil Spill Task Force

April 16 and 17, 2013

Seattle, WA

Center for Spills in the Environment

The Center for Spills in the Environment

University of New Hampshire

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1.0 INTRODUCTION

High global oil prices and increasing demand in the United States and worldwide have made the development of significant petroleum resources in Alberta, Canada economically viable. The size of the oil sands resource in Alberta requires refinery additional refinery capacity beyond what is currently available in the Midwest. In addition, there is a need to access shipping ports to deliver the petroleum to markets in the Far-East. Oil Sands Products (OSP) are already being transported to the Northwest via pipelines, ships and rail. Increased development of this Canadian resource requires preparation for potential spills by improving contingency plans and training and identifying response needs for future events.

The purpose of this workshop was to provide a basic education about OSP: What is it, where does it come from, what are its characteristics, and how is it transported? In addition, the workshop provided information for potential spill response from case studies of recent response actions and natural resource impacts.

The Washington Department of Ecology contacted the University of New Hampshire's Center for Spills in the Environment (CSE) to conduct a workshop for relevant State and Federal agencies on the important issues related to OSP characteristics, transportation and response planning. The CSE focuses on issues related to hydrocarbon spills. It is known nationally for its independence and technical excellence in the areas of environmental engineering, ocean engineering and marine science. CSE and its NOAA-funded sister center, the Coastal Response Research Center (CRRC), has conducted numerous workshops bringing together stakeholders including spill response and environmental restoration professionals, industry experts, researchers and federal and state agencies. For this training, CSE assembled a group of technical experts that could provide the participants with the knowledge required to better understand the unique characteristics of OSP and plan for potential spills of the product.

2.0 ORGANIZATION AND STRUCTURE

The training was held at the NOAA Sand Point Facility in Seattle Washington on April 16th and 17th, 2013. The first day of the workshop was an open forum which provided information to a broad group of stakeholders from the region. The second day of the workshop was a working session for response practitioners to focus on issues related to potential OSP spill scenarios. Task groups were given four potential scenarios to test the current understanding of OSP and identify future information and other needs. Breakout groups on each environment had participants with diverse backgrounds. A group leader facilitated the discussion and a note taker recorded relevant information for presentation at a plenary session.

The body of this report provides a summary of the technical information presented in the training sessions. Section 12.0 summarizes the answers to the questions provided by the breakout groups. The appendices provide:

- the agenda for the training session;
- the attendance list;
- the technical presentations;
- summary notes from the plenary sessions;
- notes and presentations from the individual breakout sessions.

3.0 OVERVIEW OF OIL SANDS DEVELOPMENT IN ALBERTA

Randy Mikula, Ph.D. (Kalium Research; Edmonton, Alberta) provided an overview of mining and the environmental issues related to the extraction and processing of OSP. The Canadian oil reserves in Cold Lake, Athabasca and Wabasca are estimated to be 170 billion bbl. Canada is third in the world in terms of petroleum reserves and the United States is currently the largest importer of Canada's OSP. The 25 year forecast suggests that total production out of Western Canada could surpass 6 mmbpd by 2035, which indicates there will need to be significant increases in transportation capacity to handle this reserve. The current transportation capacity has the ability to handle approximately 3.6 mmbpd. Proposed expansions to the Gulf and Northwest will address significant portions of this need:

- Keystone XL 700,000 bpd
- TMX expansion 590,000bpd
- Northern Gateway 530,000bpd
- CN shipment to BC

Typically, OSP consists of 73% sand, 12% bitumen, 10% fines and 5% water. [N.B., This data and all of that presented below is contained in the presentations given at the training. See the appendix for these documents.] The large percentage of abrasive materials means that OSP requires significant processing near the mining sites to prepare it for transportation to refineries, either locally or at a distance. The mining operations are conducted in two ways: surface mining and *in situ* mining. Both processes use very large amounts of water. In surface mining, the OSP is removed by mining machines and moved to locations where it is crushed, and mixed with water to remove the bitumen. The resulting mine tailings are transported to large tailing ponds where fines are allowed to settle and consolidation occurs. Water usage is significant, 2 to14bbl. per 1bbl. of bitumen recovered. From an environmental perspective, surface mining, including the large tailing ponds, results in major disturbances to the landscape. Regionally, the current extent of disturbance is ~600km,^{2} with tailing containment about ~180km^2.

The attempt to reduce water usage and speed restoration of land areas has led to the development of several methods of enhanced water recovery. The dry stackable tailings process is increasing the reuse of water (up to 70%) and allowing the potential restoration of tailing ponds sites to boreal forests to occur more quickly. The dry stackable tailing process utilizes the addition of chemical additives to consolidated tailings and release water. However the additions of these additives have raised the issue of potential toxicity to surrounding water bodies. Spreading thin layers of tailings over large areas has shown promise to speed consolidation. New technology, using centrifuges, has been shown to reduce the volume of the tailings and increase water reuse to near 80%. These new methods are decreasing tailing storage space requirements and will speed restoration potential.

The *in situ* mining process also requires extensive water use and is highly energy intensive. In the *in situ* process, steam made from saline groundwater is injected into deep oil sands deposits. Using steam assisted gravity drainage (SAGD), the head reduces the bitumen's viscosity so that it can be pumped from the ground like conventional crude oil. The water is then separated from the extracted material and recycled.

There is a significant energy input associated with the *in situ* extraction method. The standard extraction process requires huge amounts of natural gas. Currently, the oil sands industry uses about 4% of the Western Canada Sedimentary Basin natural gas production. By 2015, this may increase by 2.5 times.

According to the National Energy Board of Canada, it requires about 1,200 cubic feet (34 m^3) of natural gas to produce one barrel of bitumen from *in situ* mining operations and about 700 cubic feet (20 m^3) for those where gas and bitumen are extracted. Since a barrel of oil equivalent is about 6,000 cubic feet (170 m^3) of gas, this represents a large gain in energy. That being the case, it is likely that Alberta regulators will reduce exports of natural gas to the United States in order to provide fuel for the oil sands processing. As gas reserves are exhausted, however, oil upgraders will probably turn to bitumen gasification to generate their own fuel. The conversion of the bitumen to synthetic natural gas is a (136 m3) net gain of 4,800cu ft.

4.0 CHARACTERISTICS OF OIL SANDS PRODUCTS

To understand how OSP might react in the environment it is important to understand its physical and chemical characteristics. An overview of the characteristics of OSP was presented by Heather Dettman, Ph.D. of CanmetEnergy (Government of Canada). Bitumen is the extra heavy crude oil that remains in the geologic formation after *in situ* biodegradation processes occur. Approximately 50% of bitumen boils at temperatures below 524°C/975.2°F. Due to the biodegradation process, only the large organic acid molecules remain as part of the bitumen. These molecules have the high boiling points (>70wt% 524°C/975.2°F) and a low Total Acidic Number (TAN) of 3mgKOH/g material (3wt% in oil). This compares with vinegar which has 5% acetic acid and a TAN of 47KOH/g material.

In order to move bitumen efficiently through transmission pipelines, other petroleum products must be added to dilute it. These diluted bitumen products are called Oil Sands Products (OSP). Dilbit (diluted bitumen) is created by adding naphtha-based oils including natural gas condensate. While approximately 75wt% of the condensate has a low boiling point of 204.2°C/399.2°F, the overall boiling point of the dilbit remains high at 524°C/975.2°F. This is important because it means a small fraction <20wt% will evaporate rapidly during a spill, but the remaining fraction will not. The slower evaporation of the remaining fraction reduces the potential air quality issues for responders and the public. Synbit is made by diluting bitumen by using synthetic crude oil (syncrude) from refineries. Like dilbit, synbit maintains a high boiling point for the majority of the material.

Dilbit and synbit that is transported through pipelines must meet certain specifications for viscosity, density and acidity. In order to meet these specifications, the bitumen requires diluent by lighter oils, 30% for dilbit and 50% for synbit by volume. Both must meet a TAN of ~1.9KOH/g material with less than 3.9wt% sulfur.

Internal corrosivity in pipelines can occur as result of water, sediments, organic acids or sulfur contained in the oils or OSP. Water becomes important if the sludge in which it is contacted settles, accumulates and increases at a given location. If water soluble organic acids are present, corrosivity is increased. OSP is generally low in water soluble organic acids due to the extensive washing that occurs during the sediment removal process instituted immediately after extraction. The washing not only reduces the organic acids, but also removes mud and sand that might normally be abrasive to the pipeline. Organic acids in OSP or other crudes can cause corrosion if they become concentrated; this can occur at high temperatures in the refinery process. In pipelines, rail cars and ships these high temperatures, 280°C/392°F do not occur as the dilbit and synbit do not need to be heated to flow.

Some bitumen has been shipped without diluent in rail cars. This requires heating in order to fill and empty the cars. The high temperatures required to breakdown the bitumen and release acids are not achieved during this process.

Sulfur is contained in most crudes, OSP and diluents. If released, the acidic sulfides may react with iron to form iron sulfides. In order for this to occur, sulfur in the OSP would need to be exposed to high temperatures, (350°C/662°F) along with high pressure catalysts that are part of the refinery process. These conditions do not usually occur in pipelines, ships or rail cars.

In summary, research conducted as early as 1995, and more recently, on Alberta OSP have shown the material to be low in corrosivity.

5.0 TRANSPORTATION OF OIL SANDS

A panel of oil sands transportation experts discussed west coast the rail, pipeline and sea corridors currently utilized to move OSP. Panelists provided information on equipment, safety programs and response planning.

5.1 Rail transportation

Justin Piper of BNSF Railways reported that their system has moved mostly crude oil through their system to date, with only a small percentage being OSP transported to the U.S, (0.65%). There was a 300% increase in crude transport in 2011-2012, with no accidental releases. In 2012, there were 16 non-accidental releases averaging 3 gal. per release related to shipper related issues. In 2012 there were 3,632 shipments of light sweet crude to Washington and 1,557 to Oregon. In 2012 BNSF achieved an accident rate of 1.88/million train miles, a record for their system.

Petroleum unit trains normally contain up to 80-100 tank cars; each car has a 28,000 gallon capacity. They are constructed of 7/6 inch steel and have standard safety relief valves. Cars are typically owned, maintained and inspected by the transporter and expected to be a 40 year asset. The rail companies conduct additional inspections when the cars become part of a train. All cars are built to U.S. standards as specified in 49CFR174.

The safety program employed by BNSF has four parts: 1) community training; 2) emergency preparedness; 3) accident prevention and; 4) emergency response. The community training involves either in-person or online training for local emergency responders. Annually 3-5,000 people are trained nationwide. The emergency preparedness program involves development of an overall plan with appendices that define local response plans and environmental sensitive areas. Geographical response plans for water response that have computer linkage have been developed for specific important environmentally sensitive areas like the northwest, Mississippi River, and rail specific locations like the Columbia River, Colorado River and Glacier National Park (Flathead River) for example.

The accident prevention program utilizes onboard sensors, wayside detectors to determine break or wheel problems, and engineering systems to improve track systems. The emergency response program involves an incident response command that includes all hazardous responders, operations personnel and contractors in one unified team. The team has available GIS with identified sensitive features, preplaced equipment and responder locations to streamline response actions. Preplace equipment for hazardous spills in the northwest is located in Pasco, Seattle and Spokane Washington.

5.2 Pipelines

Michael Davies of Kinder Morgan provided background information on the current transportation of petroleum through the system, future expansion plans and the safety systems in place to prevent or respond to spills. The Trans Mountain Pipeline System (TMPL) is 715 miles long between Edmonton and Burnaby with connections to Anacortes and Ferndale in Washington (Puget Sound System). The current capacity of the pipeline is 300,000bpd with an expansion to 890,000bpd proposed to meet west coast and Far East demand. TMPL currently has 10-20 year contracts for 700,000bpd of that capacity in place. The system currently has one berth for ships at the western end of the pipeline. The current proposal is to increase that port to three berths for oil tanker transport.

Upgrades to the Puget Sound System will increase the capacity from 170-225bpd. The throughput on the pipeline to the Puget Sound system was 47% of the capacity in 2012; Burnaby and Westridge represented 28% and 21% respectively. The composition of the shipments in 2012 was: light crude 45%, heavy 22%, syncrude 17% refined products 16%.

The Westridge sea terminal currently has one berth and services 5 tankers and 2 barges per month. With the expansion to three berths the port could service up to 35 tankers and 2 barges per month. This would represent an increase in marine traffic in the system from 3 to 14%, a potential 350 additional ship calls per year.

The Kinder Morgan emergency response plan meets all of Washington State standards. The plan includes an incident command structure and field operations manuals for response actions. The program includes annual training and exercises to implement the plans. The TMPL has preplaced equipment and maintains contracts with spill response contractors Marine Spill Response Corp (MSRC), Witt O'Brien and National Response Corp NRC (by the end of the year).

The products transported meet all of the standards for temperature, density and viscosity as defined by Tariff 88. TMPL has been transporting dilbit since 1980 with no spills or operational issues.

5.3 Vessels

Dick Lauer of Sause Brothers provided an overview of the barges transporting petroleum products in the northwest inland and coastal waters. Barges are of two different sizes for coastal transport: 40-120,000 barrels for lower Columbia and Puget Sound and; 80-180,000 barrels for the ocean class. All of the barges are double hulled with vapor recovery systems.

For safety purposes the first responders are part of the barge crew. The barges are made so that the double hull can be utilized to balance the load should instability occur during transit.
The barge type that currently services the Kinder Morgan facility in Westridge is a 90,000 barrel vessel.

6.0 FATE AND BEHAVIOR OF SPILLED OIL SANDS PRODUCTS IN THE MARINE AND FRESHWATER ENVIRONMENTS

Bruce Hollebone, Ph.D. of Environment Canada provided the current information on the behavioral factors affecting OSP and the chemical changes which may occur when it is spilled in the environment. These changes, collectively referred to as weathering, are the physical, chemical and biological processes that affect the oil released into the environment. Weathering is one of the major drivers of oil behaviour (what it does in the environment?), fate (where it goes?), persistence (how long it lasts?) and effects (what it impacts?). The primary weathering processes are:

- Evaporation
- Photo-oxidation
- Water uptake and emulsification
- Particle interactions and sedimentation

- Dispersion
- Biodegradation

There are 12-13 types of OSP and they differ slightly in how each reacts in the environment based on its specific properties. Evaporation is the best known weathering process. It is a physical process where molecules leave the liquid phase, but are not changed chemically. It is normally a rapid process whereby light and medium crudes may lose 40-75% by weight over two days. OSP however, will lose 15wt% (dilbit) to 20wt% (synbit) in a few hours, but then only ~20wt% over ten days. The initial loss due to evaporation is important to understand for air quality and safety purposes for the first responders and residents in proximity to the spill.

Dissolution and solubility are minor factors (ppb to ppm levels) with respect to oil behavior, but they can impact biota and their habitats. The concentrations of the individual compounds in OSP that dissolve into water are a function of mixing energy, temperature, concentration and time.

Photo-oxidation of OSP increases the density of the remaining product and tends to increase the amount of water uptake and emulsion formation. The uptake of water during emulsification increases density and greatly increases viscosity. As a result, it changes the way OSP is transported and how it sticks to other objects. Entrained water may persist for a long time in the environment. Currently, models for photo-oxidation and emulsification are not well developed.

Particle interaction with OSP can occur in several ways and depends on the location or source of sediment. Suspended particles become adsorbed to oil and increase its density, often causing it to sink. In turbulent areas, such as surf zones or rivers with rapid currents, oil can be dispersed into small droplets where emulsification and sediment interactions occur simultaneously. These combined actions may result in tarball formation and sedimentation. Recent information from the Kalamazoo spill has shown that increased temperature may decrease the viscosity of oil allowing to be released from bottom sediments. Models for dispersion and sediment interaction are being developed.

Temperature affects many OSP properties (e.g., density and viscosity). Temperature also affects rates of weathering processes (e.g., evaporation and adsorption/sedimentation). Natural dispersion of OSP can occur if there is enough mixing energy in the water column to cause droplets to break away from the slick. Little is known about the mixing energies needed to disperse OSP, but it is less likely to occur once the lighter fractions such as the diluent have evaporated.

Biodegradation of the organic compounds of OSP will likely occur from weeks to months to years depending on conditions. Aerobic biodegradation is a much faster process than anaerobic biodegradation with nutrients and electron acceptors being the limiting factors. Microbes attack the smaller chain alkanes first followed by the unalkylated aromatics. Factors such as dispersal, burial by sediments, water quality and temperature all affect how rapidly and effectively biodegradation occurs.

There are many open questions that need to be answered in order to better predict or model how heavy oils or OSP react after a spill. The change in dilbit chemistry and behavior due to evaporation of the diluent still is not well known. The dispersion of OSP in water requires more knowledge of the droplet size, the rise time and the re-coalescence of the droplets. The interactions with sediments and the resuspension and remobilization potential are also questions that need further study. Little is also known of the impacts or long term persistence of OSP in the environment. More research also needs to evaluate the dissolution of OSP, so that bioavailability and toxicity can be established for biota present in the water column and the sediments.

7.0 THE ENBRIDGE OIL SPILL CASE STUDY (KALAMAZOO RIVER, MICHIGAN) INCLUDING RESPONSE TECHNOLOGIES FOR OSP

The Enbridge/Kalamazoo OSP spill on July 25, 2010 was a result of a ruptured pipeline. Mr. Ralph Dollhopf, EPA onsite coordinator involved with the incident presented an overview of the response for the estimated 843,000 to 1,000,000 gallon spill.

The impacted area is a 40 mile meandering river segment. During the time of the spill, the river was at the 25 yr. flood stage, which resulted in significant inundation to areas of the flood plain. The river also has numerous oxbows, islands and wetlands all which complicated the response effort. The Ceresco Dam also on the affected segment, tended to trap oil in the upstream impoundment. Initially, there was substantial confusion regarding the spill among Enbridge employees. Thus, substantial amounts of OSP were discharged adjacent to the river before the flow was stopped and the State and Federal agencies were notified. The initial notifications did not specify that the spilled oil was OSP. Hence, this further complicated the initial response. This confusion emphasized the need for excellent communication between the transportation company’s cleanup contractors, state and federal responders, and local communities during any future spills.

During the first 40 days after the spill, there was an initial remedial operation plan that included responding to the potential public health hazard that might have been caused by the benzene diluent (30%) in the air. An extensive air monitoring program was conducted during the first 30 days to protect cleanup workers. These responders utilized respirators for the first 9 days. Voluntary evacuations were undertaken for 60 residences in the immediate area. The USEPA also initiated a process to assess the amount and location of shoreline oiling, using a river adaptation of the NOAA Shoreline Cleanup Assessment Technique (SCAT). This provided a unified method for assessment and data collection that could be used for developing a cleanup strategy. The SCAT process also provided a systematic management process for the cleanup. Following the initial cleanup efforts, a SCAT reassessment of river segments was completed to determine if the areas were sufficiently clean. During the first few weeks 740,000 gals were recovered.

After the initial cleanup and SCAT reassessment, the remediation strategy turned to the overbank areas in the floodplain. The remediation of these areas was driven by a new methodology: the Shoreline Overbank Assessment Technique (SORT). SORT used a USGS inundation model to provide the guidance for identifying and assessing the locations for remediation. The SORT method was initially used in 2011 and then as ReSORT in 2012 to revisit areas that needed further action. An overall outcome of this remedial process was development of a data management system that could be employed for future spill scenarios in freshwater systems.

Because the majority of the OSP spilled is dominated by heavy oil fractions, there was a significant effort in 2011 and 2012 to remediate the submerged oil in the river. The remediation team had a difficult time identifying the location of the submerged oil. The initial identification of submerged oil areas was done by coring, water jets and long poles (poling) in 18 priority locations. Oil recovery was conducted in the spring and fall of 2011 to remediate these locations.

To improve the recovery of submerged oil, the team used a number of techniques with varying success. These included: oil low pressure sediment flushing, pressure with stingers, dredging, aeration, surface collectors, absorbent pads, pom-poms and sheen corralling.

The Scientific Support Coordination Team developed a new strategy for 2012 focusing on the submerged oil. The strategy involved:

- Reassessing all submerged oil locations;
- Minimizing ecological impacts related to recovery;
- Utilizing natural transport and sediment traps as the primary low impact method of oil capture (allowing for natural habitat recovery during the long term)

In 2012, the remediation team conducted some additional scientific studies:

- *Net Environmental Benefits Analysis (NEBA) Study*. This study weighs the risks of leaving oil in place compared to removal activities.

- *Submerged Oil Quantification Study*. This is a stratified random coring study, including all the geomorphic units in the river, to develop a valid estimate of the amount of oil present.
- *UV Epiflourescence Microscopy Study*. This study attempts to understand the structure of oil and mineral aggregates formed.
- *Biodegradation Study*. This study is focused on determining the effects of natural biodegradation on the OSP.

The results of these studies will contribute to the knowledge base for future river-based spills. The NEBA will provide a framework for evaluating the net benefits of future removal actions. The biodegradation study will provide significant knowledge regarding the potential value of biodegradation as part of an overall cleanup strategy for OSP spills.

8.0 BURNABY OIL SPILL CASE STUDY

The Burnaby oil spill at Westridge occurred on July 25th 2007. Bill Jahelka of the Western Canada Marine Response Corporation (WMRC) reported on their response to this dilbit spill. The spill was estimated to be 232,000 liters (1400 barrels) and the response by WMRC was rapid with the first skimmer being placed around the spill within an hour. Aerial photos showed that some oil did get beyond the main skimmer however.

WMRC employed a variety of skimmers including skimmer vessels to capture the bulk of the oil. This process took five days. The oil that reached the shore line was cleaned by using Corexit 9580 A as a cleaning agent and then washing the oil into the adjacent boomed shallow water. This oil was then captured using skimmers and vacuum trucks. This process took two months.

Crab traps with sorbent material were utilized to determine if submerged oil was present. No submerged oil was detected. A monitoring program was conducted for eighteen months to insure no oil remained. The cleanup captured 210,000 liters of the 232,000 spilled.

This cleanup resulted in several findings applicable to future spill responses:

- Diluted bitumen did not sink in this situation (minimal wave action and wind, warm temperatures, clear salt water);

- Response equipment worked well during both containment and recovery;

- Shoreline equipment (low pressure deluge, passive recovery) in combination with Corexit was effective;
- Excellent response network support and rapid response resulted in an effective recovery.

10.0 ASSESSING NATURAL RESOURCE IMPACTS FROM THE ENBRIDGE PIPELINE SPILL INTO THE KALAMAZOO RIVER

As part of the Enbridge/Kalamazoo cleanup, the resource trustees initiated a Natural Resource Damage Assessment (NRDA) to determine the value of the natural resources lost or damaged as a result of the OSP spill. Jessica Winter (NOAA), a member of the NRDA team, reported on the activity to date, including ongoing trustee's data collection.

The Oil Pollution Act of 1990 (OPA 90) and the subsequent regulations, established the requirement to assess the damages from oil spills and make the public whole for the loss of any natural resources and natural resource services. Damage assessment requires that the natural resource trustees are chosen from among the responsible natural resource agencies in the area. The NRDA then proceeds through a stepwise process that includes:

- An initial resource assessment to determine whether injury to public trust resources has occurred.
- Trustees quantify injuries and loss of services and identify possible restoration projects using economic and scientific studies to compensate for the injuries and losses. In assessing the losses the trustees must evaluate the spatial extent of the injury, severity and duration.
- These impact assessment studies are used to develop a restoration plan and potential compensation for loss or impairment from the time of injury to recovery.
- The final step is to implement restoration and monitor its effectiveness, including adjustments, if required.

For the Enbridge/Kalamazoo spill, eight trustees, including two tribes, were designated to oversee the NRDA process. In discharging their responsibility, the trustees are conducting an assessment to determine what resources might have been impacted and identify the potential injuries. The trustees are coordinating with the response agencies to determine what information had been previously collected as part of the remediation process that might be useful in the NRDA process. Gaps were identified that would be needed to quantify the injury. Data from the literature or studies from similar environments can be utilized to provide insight into the river's baseline ecosystem.

The trustees initiated a number of studies to fill the data gaps necessary to determine the extent of injuries. These studies took into account: the nature of the oil spilled, the identified locations of oil damage, and impacts related to the remediation itself. The studies included:

- The extent of oiling in the floodplain habitats;
- Vegetation surveys to determine the extent of oiling and potential invasive species expansion;
- Erosion issues related to the remediation;
- Fish kills and ongoing monitoring surveys for status and trends;
- Fish tissue surveys to assess potential exposure and sub-lethal health issues;
- Abundance and diversity of macroinvertebrates impacted by the sinking oil and cleanup process; (The cleanup process has the potential to impact habitat (e.g., sediment and vegetative cover)).
- Mussel shell surveys to further assess the impacts of the spill and remediation on these populations;
- Chemistry studies of source OSP, water, sediment and biota;
- Wildlife recovery studies using animals treated at rehabilitation center and;
- Human use studies to determine the loss of the river for human recreation for two years.

As these studies are completed and the impacts analyzed, the trustees will determine if any additional data gaps exist and then initiate the restoration and compensation phases of the NRDA. Reviewing the findings of these studies will be helpful to understanding response actions for any future OSP spills in in Northwest. Data from 2012 indicates that the fish community in Talmadge Creek is showing some recovery, but changes in habitat due to the cleanup are affecting the type of community that is there. In the Kalamazoo River there is still lower diversity and abundance at some sampling locations. The macroinvertebrate community in the Kalamazoo appears healthy while the community in the Talmadge is not as healthy, suffering in part from habitat changes due to the cleanup activities.

11.0 POTENTIAL AREAS OF IMPACT AND RESOURCES AT RISK FROM OSP IN PACFIC STATES AND BRITISH COLUMBIA

The first day of the Pacific States/British Columbia training session provided an overview of the nature of OSP, the transportation issues associated with it, its potential impacts in the event of a spill, and information from case studies for strategies that might be employed to cleanup an OSP spill. On the second day, the working session, Linda Pilkey-Jarvis and Danielle Butsick of Washington Department of Ecology provided an initial overview of the status of the potential transportation corridors (rail, pipeline and shipping) and petroleum facilities used to handle OSP, and the potential resources that might be at risk. This presentation demonstrated the information available to responders in the region and how it could be utilized in response planning.

Northwest shipping trade is closely allied with Asia. The increase in available OSP as discussed will increase the number of ship calls in the area. Waterways carry diverse vessel traffic in inshore waters making the potential for accidents possible. There are six pipelines in the area which carry petroleum products. Oil terminals are primarily located in water bodies and transfer oil across docks or through pipelines. Grays Harbor has three new proposed terminals and another is proposed for the Columbia River. Four railroads cross the area including BNSF, Union Pacific, Columbia Basin and Cascade and Columbia River Railroad, the most significant being BNSF.

There are significant tools available for Pacific States oil spill responders including:

- Environmental Sensitivity Maps (ESI);
- Environmental Response Management Application (ERMA) for Puget Sound- an online GIS tool with static and real time data for responders;
- Washington State Coastal Atlas providing public access, natural resource and sensitive habitats.

By using these tools and other available data and overlaying this information with transportation corridors and facilities, it is possible to identify the potential resources at risk. It is understood that not all environmental data is incorporated into the tools at this time, but they are being improved over time. Important resources include:

- Rivers, streams and sole source aquifers;
- Priority species habitats;
- Threatened and Endangered Species;

- Public access and recreation;
- Tribal Resources (subsidence, cultural, economic natural).

The Department of Ecology is using all of these tools to develop response plans for various potential spill scenarios. Plans are updated annually.

12.0 BREAKOUT GROUP DISCUSSIONS OF OSP RESPONSE STRATEGIES

The Organizing Committee developed four scenarios to be addressed by the participants that represented potential transportation and facility risks in the region. Workshop participants were distributed into one of four breakout groups based on their experience and expertise. Each breakout group had a Group Leader (facilitator) and a Recorder (note taker). The spill scenarios included: Vessel – Marine (North Puget Sound- Salish Sea); Train- Inland River (Kalama area); Pipeline-Inland (Ferndale area) and; Facility-Marine (March Point Refinery dock).

Each of the groups was given five questions to direct their discussion:

1. For your scenarios, what would the response be now?
2. What issues/challenges would the response face (e.g. for the environmental unit, logistics, human dimension, health and safety) that are unique to these OSP scenarios?
3. What information is needed and what questions should be answered to improve the response to these scenarios? Prioritize theses needs /answers (i.e. 12 months, 2-3 years, and 4+ years).
4. How does Contingency Planning need to change to accommodate an OSP spill?

By discussing and answering these questions, the groups were able to evaluate current readiness for an accident and also recommend and prioritize actions that should be taken to better prepare response agencies for future contingencies.

12.1 Vessel - Marine

Group members:

Gary Shigenaka, NOAA (Group Lead)

Carol Bua, Tidewater Barge Lines

Tom Callahan, WA Maritime Cooperative

Brendan Cowan, San Juan County, Dept. of Emergency Mgmt.

CPT Scott Ferguson, U.S. Coast Guard, Sector Puget Sound

Kurt Hansen (via WebEx), U.S. Coast Guard, Sector Puget Sound

Bruce Hollebone, Environment Canada

Julie Knight, Islands' Oil Spill Assn.

Dick Lauer, Sause Bros. Ocean Towing

Mike Moore, PMSA

Linda Pilkey-Jarvis, Washington Dept. of Ecology

Charlie Watkins, UNH Center for Spills in the Environment (Recorder)

Scenario:

> **At 0130 on April 14th, a laden tug and barge carrying 85,000 barrels of oil sands product transited southbound out of Rosario Strait and crossed over Lawson Reef. Low tide was 4.94 feet at 0122. Due to the relatively high speed of the vessel when it struck the reef, both layers of the double-hulled barge were damaged. This resulted in a release of approximately 60,000 barrels of oil sands product into the waters of Puget Sound. Weather on-scene has been mild storm conditions with 35kt winds from the south and 5-7ft swells. High tide this morning was 6.09 feet oat 0848; low tide will be .92 feet at 1543 this afternoon. Initial reports mentioned a significant sheen around the vessel. Notifications were made and unified command formed.**

The Group indicated that the current approach to respond to this spill would be similar to that of a crude oil spill. This would require the establishment of a full Incident Command Center to oversee all activities. The Environmental Unit (EU) would need to immediately establish an air monitoring and safety program to protect the public and establish the safety protocol for the responders. During early aspects of the response, the resources at risk and the extent of the spill needs to assessed. The Group recognized the need to identify the characteristics of the OSP spilled beyond the MSDS. This would greatly assist in establishing safety protocols and determining cleanup strategies. Specifically it was determined that knowledge of the diluent and the characteristics of the OSP would be central to the response action.

The Group identified several technical and logistical issues that would need to be addressed for this spill. A significant question for responders is whether the OSP will sink in the choppy seas or if it will float and be easier to recover as at Burnaby. The cleanup of shoreline is important in this narrow channel area. What is the most effective method? The question of whether dispersants would work or in-situ burning might work was also discussed.

From the perspective of logistics the availability of benzene air monitoring equipment is important. Available safety equipment for responders for the appropriate thresholds is important to have on scene. Training of local responders is necessary as part of the planning process. It was also the consensus that having an effective method of communication to the public is a high priority to provide the correct information and avoid misunderstandings. There is a need to better understand issues of toxicity and seafood safety. Current toxicity information is not adequate, including safe levels in food.

In order to prepare for OSP spills in the future there is an immediate need for equipment inventories and locations for response planning. Lessons learned from previous spills are important to make available to responders to improve future responses and reduce missteps. To improve communication, developing accurate and concise messaging material about oil sands would be helpful for those charged with communicating to the public and the media. In the longer term, there needs to be a better understanding of the implications of cross border issues to improve communication and response. There is a need for more research on the OSP response methods including:

- Dispersants,
- *In situ* burning,
- Surface washing agents for shoreline cleanup,
- Modeling to assist with OSP behavior.

To improve contingency planning for future marine spills additional protocols should be developed for air monitoring, surface and subsurface responses. More information on transportation of OSP needs to be part of the planning, and OSP response actions need to be incorporated into drills so that responders have the knowledge and experience to provide timely and effective response to OSP spills.

12.2 Train - Inland River

Group Members:

Josie Clark. US.EPA, Region 10 (Group Lead)

Joe Bowles, MSRC, PACNW Region

Heather Dettman (via WebEx), Canmet Energy

Dan Doty, WA, Dept. of Fish & Wildlife

Faith Fitzpatrick (via WebEx), USGS

Richard Franklin (via WebEx), U.S. EPA, Region 10

Dale Jensen, WA, Dept. of Ecology

Lance Lindgren, U.S. Coast Guard, Sector Puget Sound

Bill Lywood, Crude Quality/ CAPP

Brad Martin, Ecology and Environment, Inc.

Jim Morris, Witt O'Brien

Heather Parker, USCG

Don Pettit, Oregon DEQ

Justin Piper, BNSF Railroad

Ernie Quesada, Clean Rivers Cooperative, Inc

Holly Robinson, Maritime Fire & Safety Assn. (MFSA)

Calvin Terada, U.S. EPA, Reg. 10

Jessica Winter, NOAA ORR ARD

Jeff Smith, University of Washington (Recorder)

Scenario Train – Inland River:

> **As a result of a long period of wet weather in the Kalama, WA area, a series of landslides has begun occurring in the steeper areas along the banks of the Columbia River. A unit train consisting of 120 cars each carrying 600 barrels of undiluted bitumen oil was transiting a rail line that runs adjacent to the river, when it was derailed by a landslide. Three tank cars are off the tracks at river mile 79 (45.963121,-122.811828). At least one is known to be compromised and leaking oil into the Columbia River. Initial reports estimate at least 600 barrels are in the water. Based on volume observed, it is likely that the other two derailed cars are leaking as well. The river is flowing at 200,000 cubic feet per second (flowing**

toward Kalama) and is approximately 50ft. deep in this area. Notifications were made and unified command was formed.

The group determined that the response would need to include both surface and subsurface cleanup given the nature of OSP. To effectively respond would require the ability to track the subsurface plume effectively given river flows of 200,000cu.ft./sec. Because the River serves as a water source it would be extremely important to identify the existence of water intakes and make determinations as to whether the intakes need to be shut down.

Resource Trustees would need to be contacted to identify the potential resources at risk in the area of this spill. This knowledge could be utilized to prioritize response activities. The resources would include not only surface and water column species, but also bottom dwelling species, and those in adjacent wetland and floodplains. Information on the bathymetry of the area would be important to identify likely areas of deposition for subsurface oil.

It is assumed that the railroad would provide cleanup contractors and be responsible for source control and recovery of the rail cars. They would also be responsible for air monitoring networks in this scenario.

There is a need to provide accurate information to the public about this spill. This would include information on any known toxicity issues and the closure of any fisheries. There is a lack of knowledge locally of the most effective methods of response to an OSP spill. Thus, there is a need to understand lessons learned from previous OSP spills.

High priority information needs in the near future include: Where is the submerged oil recovery equipment located in the region for deployment; who has the expertise to handle this type of spill and where are they located and; what are the strategies to protect water intakes from submerged and surface spills.

Informational needs of medium priority include knowledge of sampling and initial surveillance monitoring techniques that are effective for OSP spills. A greater understanding of effective containment and recovery techniques for OSP and also what are their limitations. More information on the toxicity of Class V would be important research to have available to help with planning and response. Longer term research priorities include effective long term monitoring strategies, well developed case studies for previous spills and understanding the fate and transport of OSP spills in freshwater environments.

New contingency planning (Northwest Area Committee) will occur during 2014. As part of the planning there is a need for developing fact sheets on OSP similar to NOAA's. A task force should be assembled to incorporate planning for OSP spills into the Contingency Plan. As part of the planning process it would be important to develop a list of experts who could be utilized during an OSP response including those with expertise in resources at risk and those with knowledge of bathymetry and river processes. Assembling information and reports from previous spill OSP response efforts and best available technology for submerged oil containment and recovery in freshwater would assist responders in planning and training.

12.3 Pipeline - Inland

Group Members:

David Byers**,** WA, Dept. of Ecology (Group Lead)
Shayne Cothern, Washington Dept. of Natural Resources
Ralph Dollhopf (via WebEx), US.EPA.
Chris Field, US.EPA, Region 10
Randy Mikula, Kalium Research
Kathy Weed, National Response Corp
Joe Inslee, NOAA/University of Washington (Recorder)

Scenario Pipeline – Inland

> **At 0430 on April 16th, the pipeline control center notices a pressure decrease in the 16" line as it is transferring a batch of oil sands products to the receiving refinery. This triggers a SCADA system alarm, which prompts control center personnel to order the pump station to be shut down. Emergency shutdown procedures are initiated and the pipeline is isolated between block valves. The pressure continues to drop in the line section adjacent to Tennant Lake in Ferndale, WA. Local 911 receives a report of oil in the marsh area around Tennant Lake as well as several calls from residents of a nearby subdivision reporting a strong petroleum odor. The pipeline initiates a response. Notifications are made and unified command is formed.**

Group C discussed in detail how a response to OSP in a wetland adjacent to a leaking pipeline would occur. The response as discussed followed protocol of a heavy oil spill, but with a significant concern for air quality concerns related to the diluent. There was concern whether there are available air quality monitors to address health and safety concerns. Primary response contractors for this spill were identified and it was suggested that these contractors would have the equipment and monitors to enter the site. It was noted that at the Kalamazoo spill the responders wore respiratory protection for nine days.

The spill into the wetland would bring significant challenges to the cleanup process. These challenges would include access to the area, establishing an effective containment system and then cleaning up the OSP without destroying habitat, and if there is enough equipment that can be mobilized quickly and efficiently. The ability to monitor and respond to sinking oil was deemed to be the biggest challenge for responders. One question raised that is germane to all of these cleanup scenarios is who will be responsible for deciding the response net environmental decision? Is there an adequate protocol and information to make those decisions?

Community relations are an important aspect of the response to this spill. The stigma of OSP means that outreach needs to be aggressive and factsheets need to be developed which present clear and accurate information about the product. Continued outreach must occur throughout the cleanup process to keep the public informed about the progress of the response and any restoration efforts. It is also important to identify if any tribal interests might be impacted by the spill and insure the tribes are kept informed. It is assumed that tribes would be designated Trustees as part of any NRDA process and on scene when any ESA issues are being addressed as part of the cleanup.

The most significant challenges facing responders to the spill include: accurate product information about the OSP and diluent; obtaining the needed air monitoring equipment to protect the public and responders; effective cleanup methods in the wetland and; effectively finding and recovering the sunken oil. It was felt that was a need to identify methods and equipment that might be effective for recovering oil on the surface or bound to the sediment. Are there lessons to be learned from the Kalamazoo spill that would improve the net cost-environmental benefit of a wetland river cleanup?

Information needs to improve response to an inland pipeline spill were prioritized by <12 months, 2-3 years and 4+ year timeframes. Short term informational needs were based on better understanding the nature of OSP, diluents and the potential air and health and safety issues that need to be addressed with an OSP spill. In the 2-3 year time frame more information is required on:

- Chronic toxicity
- Case studies on net-environmental benefits and restoration
- OSP sinking factors and timing

- Effectiveness of dispersants on OSP
- Weathering data for OSP

In the longer term, more information on the detection of sunken OSP and recover tactics is essential. The development of toxicity and behavior models would also be helpful for future OSP spills. An understanding of any groundwater impacts related to inland spills would also be important to decision makers.

The revision of contingency plans to address OSP product spills must include information about diluents and the actions required to address these products in the air and water. As the diluents change this information may need to be revised. Identification of the type and location of clean up and air monitoring equipment needs to be included in the plan updates. Sections on subsurface oil containment and recovery will need to be added to the plan. Identification of OSP cleanup and restoration expertise should also be identified.

12.4 Facility - Marine

Group Members:

Sarah Brace, Pacific States/B.C. Oil Spill Task Force (Group Lead)
Yvonne Addassi, CA Dept. of Fish & Game, Ofc of Spill Prevention & Response
Bart Dodson, National Response Corp
Graham Knox, Pacific States/B.C. Oil Spill Task Force
Scott Knutson, U.S. Coast Guard, D13
Scott McCreery, BP Cherry Point Refinery
Bob McFarland, U.S. Coast Guard, D13
Chris Stadiem, Marine Spill Response Corp (MSRC)
Ruth Yender, NOAA ORR ERD
Jim Flood, UNH Center for Spills in the Environment (Recorder)

Scenario Facility – Marine

> **On April 16th, a tank barge is on the outside berth at the March Point refinery dock offloading oil sands product into tanks 24 and 25. The facility is located in Skagit County. The weather is relatively calm until approximately 0047, when a high-intensity storm comes through the area, compromising the boom placed around the transfer site. As crews rush to shut down the transfer, the pump on the tank barge**

suffers a catastrophic failure and spews crude oil onto the deck and into the water. The boom traps some of the oil, but the majority escapes. Winds are driving the oil east, towards Padilla Bay.

The Marine Facilities Task Group indicated that the response to the marine facilities OSP spill would be similar to other heavy oils but the volatiles from the diluent might evaporate faster. Health and safety response will also be similar to other heavy oil spills except that because of public concerns about OSP there is a need to be proactive about public outreach and public health issues.

There are a variety of response options to the spill including booming, skimming and possibly burning. Dispersants are not allowed in the Bay. A net benefit analysis would be important in deciding on the response. There is potential for OSP to be stranded intertidally and resuspended. Intertidal cleanup would potentially be an issue in this water body; Corexit is not an option for cleaning as it was utilized for the Burnaby spill.

In the future the Group identified the need for more definitive information on the characteristics of dilbit and synbit products. Case studies should be compiled to understand: spill response and the effectiveness of the actions; public perception and how to provide better public outreach and; develop a common terminology for OSP spill response. There is a real need to understand the health effects of various dilbit/synbit products beyond MSDS information.

Models need to be developed to better predict the fate and transport of OSP in the marine environment. This includes information on sinking and weathering. OSP products also should be added to the ADIOS database for use by responders. Data and/or case studies on the use of dispersants, *In situ* burning and other alternative measures should be compiled for use by decision makers and responders.

13.0 SUMMARY OF BREAKOUT GROUP DISCUSSIONS

There were several consistent recommendations made by the breakout groups. They included actions that should be taken to improve near term and longer term OSP spill response and update Contingency Plans for marine, rail, pipeline and shoreline facilities. These recommendations include:

- In the near future, develop better communication between agencies, the private sector, the OSP industry, tribes and communities to improve response times and make important information more readily available.
- As studies are completed, improve our understanding of the human health and safety issues associated with an OSP spill; in the short term ensure that responders are equipped with the right equipment to monitor the safety of communities and responders.
- Obtain and disseminate information about OSP characteristics (i.e., toxicity, behavior, components) as they become available. Industry has an important role in providing this information.
- Compile case studies and information about effective responses to OSP spills in fresh and marine environments. Update the area plan with information on monitoring capability and protocols;
- In the near future, identify the equipment to assess and cleanup potential subsurface spills that are potentially significant in an OSP spill; in the longer term identify tactics to address potential subsurface spills.
- Better understand the fate and transport of OSP in the environment.
- Better understand the net environmental tradeoffs in order to make cleanup decisions in a variety of environments including subsurface.
- Understand the acute and chronic toxicity associated with OSP in the environment and particularly for threatened and endangered species.
- Identify experts associated with OSP response, environmental impacts and important habitats and incorporate them into revised Contingency Plans.
- Use drills to test the readiness of people and equipment to respond to an OSP spill in a variety of environments.

14.0 APPENDICES

- The agenda for the training session;
- Attendance list;
- Technical presentations;
- Summary notes from the plenary sessions;
- Notes and presentations from the individual breakout sessions.